

## CLAIMS

1. An apparatus for protecting occupants of vehicles, said apparatus comprising:

an object detector configured to monitor a position of an object relative to a vehicle;

a processor in communication with said object detector and configured to determine a likelihood of a collision between the vehicle and the object based upon data received from the object detector; and

a deployment device in communication with said processor and configured to deploy a physical safety countermeasure before the collision occurs if said processor determines that the collision is likely.

2. The apparatus of claim 1, wherein said processor is configured to determine a likelihood of a collision between the vehicle and the object occurring within less than 1 second after a present time.

3. The apparatus of claim 1, wherein said deployment device is configured to:

deploy at least one of an irreversible physical safety countermeasure and a reversible physical safety countermeasure before the collision occurs if said processor determines that the collision is likely within a first time period after a present time; and

deploy a reversible physical safety countermeasure before the collision occurs if said processor determines that the collision is likely within a second time period after the present time.

4. The apparatus of claim 3, wherein said at least one of an irreversible physical safety countermeasure and a reversible physical safety countermeasure comprises an irreversible physical safety countermeasure if at least one of:

- a closing rate between the vehicle and the object exceeds a threshold rate; and
- a speed of the vehicle is above a threshold speed.

5. The apparatus of claim 3, wherein the first time period comprises a time period approximately between 0.3 and 0.5 second after the present time.

6. The apparatus of claim 3, wherein the second time period comprises a time period approximately between 0.5 and 1.0 second after the present time.

7. The apparatus of claim 1, wherein said object detector includes a radar-based device.

8. The apparatus of claim 1, wherein said deployment device is configured to deploy the physical safety countermeasure before the collision occurs if said processor determines that a probability of the collision is greater than 99%.

9. The apparatus of claim 1, wherein the physical safety countermeasure is configured to at least one of change a height of a bumper on the vehicle, tighten a seat belt on the vehicle, apply a brake on the vehicle, inflate an air bag on the vehicle, and control steering of wheels of the vehicle.

10. The apparatus of claim 1, further comprising a vehicle movement detector in communication with said processor and configured to monitor movement of the vehicle, said processor being configured to determine a likelihood of a collision between the vehicle and the object based upon data received from the vehicle movement detector.

11. A method of protecting occupants of vehicles, comprising the steps of:

sensing that a vehicle is likely to be involved in a collision occurring within less than 1 second after a present time; and  
deploying a safety countermeasure before the collision and in response to said sensing step.

12. The method of claim 11, wherein the sensing step includes monitoring a position of an object relative to the vehicle and sensing that the vehicle is likely to be involved in a collision with the object.

13. The method of claim 11, wherein the sensing step includes monitoring movement of the vehicle.

14. The method of claim 13, wherein the monitoring step includes monitoring at least one of vehicle speed, rate of change of vehicle speed, direction of vehicle movement, and rate of change of direction of vehicle movement.

15. The method of claim 11, wherein the deploying step includes at least one of changing a height of a bumper on the vehicle, tightening a seat belt on the vehicle, applying a brake on the vehicle, inflating an air bag on the vehicle, and controlling steering of wheels of the vehicle.

16. A method of protecting occupants of vehicles, comprising the steps of:

sensing that a vehicle is likely to be involved in a collision; and  
deploying a physical safety countermeasure before the collision  
and in response to said sensing step.

17. The method of claim 16, wherein said sensing step comprises sensing that the vehicle is likely to be involved in a collision that will occur within less than 1 second after a time of the sensing.

18. The method of claim 16, wherein the sensing step includes:

sensing that the vehicle is likely to be involved in a collision with  
an object; and  
monitoring a rate of change of a position of the object relative to  
the vehicle.

19. The method of claim 16, wherein said deploying step includes choosing at least one of a reversible physical safety countermeasure and an irreversible physical safety countermeasure dependent upon a time at which the collision is likely to occur.

20. The method of claim 16, wherein the sensing step includes:

sensing that the vehicle is likely to be involved in a collision with  
an object; and  
monitoring movements of both the vehicle and the object.

21. The method of claim 16, wherein the sensing step includes:

calculating a plurality of factors related to movements of at least one of the vehicle and an object;

calculating a decision rating based upon the factors; and

comparing the decision rating to a threshold value.

22. The method of claim 21, wherein the decision rating is calculated as an average of the factors.

23. The method of claim 21, wherein the factors include at least one of an offset from lane center based missed distance, a ratio of projected lateral movement to required lateral movement, a radius of curvature of the vehicle, and a projected Y intercept.